Antibiotic Resistance: A Growing Threat to the World

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Key points:

- Introduction
- Mechanism of Antibiotic resistance
- Causes
- Recommendations

Introduction

Antimicrobial resistance (AMR), is the condition in which microorganisms are resistant to antibiotics, antiviral and other such agents and spread in the presence of drugs that were impactful against them, rendering treatments futile.[1] Antibiotic resistance is the existence of pathogens after the exposure of antibiotics that could otherwise terminate them or restrict their escalation in normal situation. There are some reasons of bacterial resistance against antibiotics, including the degree of struggle expression of the bacterial strain and its endurance through resistance procedures.[2]

Mechanism of Antibiotic Resistance

Antibiotic resistance mechanisms can be distinguished into four main groups: Drug Inactivation, Limiting drug uptake, altering drug target, high levels of drug efflux.

Inactivation and modification of antibiotics is one of the most known methods used by bacteria to elude its action, results in the permanent destruction or counteraction of antibiotics. The mechanism of enzymes can include damaging the enzyme active site, hindering binding, e.g., the hydrolytic cleavage action of β-lactamases on the β-lactam ring of β-lactam antibiotics. Another action is the covalent modification of vital structural antibiotic features, blocking its interaction. e.g., the alteration of hydroxyl/amino groups on antibiotics by
aminoglycoside-modifying enzymes (AMEs).[3]

Outer membrane (OM) remodeling is an essential antibiotic resistance method observed in bacteria (mostly in Gram-negative), lowering the influx of antibiotics, following in their existence. Membrane remodeling causes bacteria to eliminate specific constituent of the membrane like lipids and proteins to adjust to a new atmosphere.

New proteins e.g. porins can merge into the membrane or degradation of present proteins. The addition of new proteins to the OM starts in the cytoplasm where protein precursors of porins are formed before relocated to the IM and periplasm.[3]

Amendment of drug binding sites found in Gram-negative bacteria are a crucial process in which they become multiple drug resistance (MDR), with an example of this being changes of Lipid A. Lipopolysaccharides (LPS) are key molecules found in the OM of Gram-negative bacteria, accelerating bacterium steadiness and defending the bacteria from the external surroundings. Furthermore, the key molecules in Gram-negative bacteria toxicity, starting host immune responses by interacting with host signaling receptors. Gram-negative bacteria have evolved enzymes called Lipid A-modifying enzymes through evolution altering the Lipid, A region of LPS that allows these bacteria to elude host immune feedback.[3]

Efflux pumps are crucial proteins complex in antibiotic resistance and are found in all bacterial class. These complex transporter proteins are generally located in the intermembrane and outer membrane of Gram-negative bacteria, superintend for the extrusion of pernicious substances from the cell wall like antibiotics. This outcomes in a lower antibiotic concentration inside the cell, meaning the bacteria can withstand high saturation level of antibiotics. The lately recognized family known as the proteobacterial antimicrobial compound efflux (PACE) family. These active efflux systems play a important role in working out resistance to a variety of chemically various antibiotics and antimicrobial agents, and instances of their occurrence is rapidly accelerating in both clinical and environmental bacterial strains. Significantly these systems are closely global over all bacterial kingdoms, putting up to antibiotic resistance through their shared ordinary resistance techniques.[3]

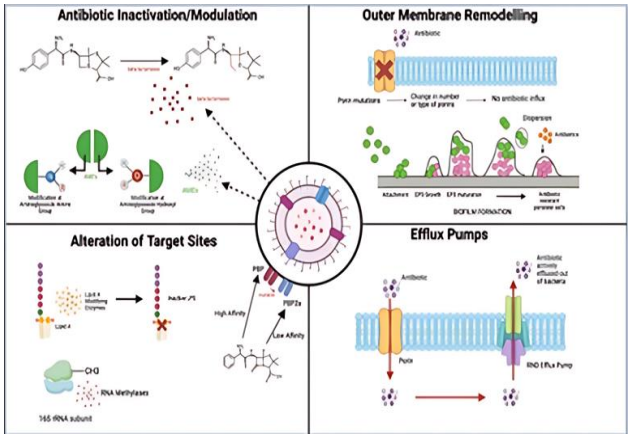


Figure 1: *Four ways of antibiotic resistance by gram negative bacteria*

Causes

The misuse of antibiotics led to the evolution of resistance. Epidemiological research has illustrated a direct relationship between antibiotic utilization and spreading of resistant bacteria strains. Inappropriate prescribed antibiotics also results to the exceeding of resistant bacteria. Research shows that treatment indication, option of agent, or duration of antibiotic therapy is erroneous in 30% to 50% of cases. In both developed and developing world antibiotics are generously used as growth promoter in livestock.[4]

Global travel and trade are one of them as people, animals, and goods move swiftly across neighboring borders, resistant bacteria are easily imparted between regions. Travelers who cultivate resistant infections overseas may bring along with them to their home land where they can open out to others, causing local epidemic.[6]

Environmental contamination plays progressively important part in the multiplication of antibiotic resistance. Antibiotic leftovers from pharmaceutical production, agricultural practices, and healthcare waste can access the environment over wastewater, sewage, and runoff. Self-medication and the incomplete courses of antibiotics further aggravate the problem. In many areas of the world, mostly in developing countries, person purchase antibiotics without a prescription and employ them for conditions that does not even need them, like mild infections or viral. This practice of self-medication accompanies to the misemploy of antibiotics, exposing bacteria to these drugs without proper instruction on correct usage. Moreover, a lot of patients give out to complete the full course of treatment leaving a subset of bacteria that leads to have developed some resistance.[5] Bacteria can react to an extensive range of environmental threats like severe heat, cold, alkalinity and salinity. Humans are exposed to resistant pathogens from other people, mostly in hospitals or community gatherings. Common dispersal ways are via body contact or indirect contact by air and food.[6]

Recommendations

Strategies to reduce AMR should be written off as regulation (structural or organizational actions), education (health-care worker trainings), or optimization (responsible antimicrobial use).[7] Recommendations to address issue of antibiotic resistance include, reviving the production of new antibacterial drugs and awareness of funding opportunities to research communities. The doctor should recommend other antibiotic if no effect is seen. The intricate biological interactions can be showed using AI algorithms and the molecular dynamics can be simulated, which makes the forecasts based on the effectiveness and toxicity more precise compared to the traditional experimental methods.[8] The pharmacies should not be allowed to sell the medicine without the prescription of doctor. Avoid use of antibiotics in livestock as growth promoter and complete use of antibiotic medication properly by patients.

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